工业工程系列教材

上海汽车工业教育基金会　组编

工业工程专业英语

白庆华　主编

上海交通大学出版社

上海汽车工业教育基金会资助
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Professional English for Industrial Engineering

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内 容 提 要

本书是根据国家教委高校理工科《大学英语教学大纲》对专业英语阅读的要求编写的。大纲指出，专业英语主要是培养学生阅读专业英语书刊、杂志的能力，能顺利阅读并正确理解有中等难度的专业外文文献，阅读速度要求达到每分钟 70 词，阅读理解和准确率以 70%为合格。

本书内容从大量北美、英国近些年来较为权威和读者数量大的书籍和杂志中精选而来，以确保专业内容权威、新颖和语言文法、习语的正宗规范。选材内容广泛，覆盖工业工程所涉及的主要领域，如工业工程、系统工程与仿真、生产过程设计、生产设施定位布局、物流工程与管理、人因工程、信息管理系统、质量管理、绩效评定、项目管理、财务管理、经营管理、人力资源管理、计算机应用等。为便于学员自学阅读，对每篇文章都给出了中文译文，以供参考。

本书为高校工业工程本科专业的专业外语教材，也可作为管理科学与工程、技术经济等其他专业的外语教材，亦可作为研究生、研究人员和技术工程人员的学习参考书。

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总　序

作为市场经济产物的工业工程学科，在美国的发展已有100年的历史，它在西方国家的工业化进程中和在改善经营管理、提高生产率等方面都发挥了很大的作用。近10多年来，随着商业竞争的加剧，国际市场和全球化制造态势的形成，企业和商家纷纷寻求进一步改善经营管理的方法，试图建立自己的核心竞争力，以便在激烈的竞争中取胜。企业和商家的这些努力是与管理专家的研究结合在一起的，这样就大大地推动、丰富了工业工程和管理学科的发展和内容的更新。

虽然在上世纪三四十年代，交通大学等一些大学曾设立过与工业工程类似的学科，但解放后随着计划经济的实施，这个学科也就取消了。这样，这个学科在我国的研究和应用就停滞了30多年。改革开放后，在原机械工业部的积极推动下，我国从1989年开始引进工业工程的管理方法，并在一些企业试行，取得了明显的经济效果。西安交通大学、天津大学等高校率先于1992年开始招收工业工程专业的本科生。随后，我国一些大学陆续设立这个专业，至今全国已有70多所高等学校设有这个专业；这个专业的硕士和博士生也在培养之中。但是，正由于起步较晚，我们无论在工业工程的应用还是人才培养等方面都落在先进国家的后面。

上海汽车工业(集团)总公司是一个现代化的大型企业集团，集团公司所属的许多生产厂不但拥有现代化的设备，而且也努力推行现代的管理方法。在实践中，他们深感缺乏既懂工程又懂管理的复合型人才。为了广泛普及现代的管理方法，公司的高层领导把员工的教育和培训摆到了重要的地位。他们除经常举办短期训练班普及现代管理知识外，还委托上海交通大学连续举办了几届“工业工程”专业工程硕士班。为了解决硕士班的教材问题，他们引进了部分国外最新教材，供上课老师使用。

为了支持工业工程专业人才的培养，解决工业工程专业的教材问题，由上汽集团及所属企业捐资组建的“上海汽车工业教育基金会”，从2000年起就开始研究资助这个专业教材的编写和出版问题。经上海汽车工业教育基金会与上海交通大学出版社共同策划，并先后与上海交通大学、同济大学、东华大学、复旦大学、上海大学和上海理工大学等校工业工程系老师座谈、讨论，于2001年8月正式成立了“工业工程系列教材编委会”，制订了系列教材编写和出版计划。按照这个计划，系列教材共计14种，由2002年起分3年出版。基金会拨出专款资助系列教材的编写

和出版。我们对上海汽车工业教育基金会给予工业工程专业教育的支持表示感谢。

在确定系列教材的选题时，我们主要考虑了以下原则：一是特色，要有工业工程学科的特色，选题应确属工业工程学科的课程，对一些可与其他学科共用的教材则不再列入；二是精选，编写内容应精选该学科公认的、经典的基本原理和方法，以及先进的管理理念，对一些尚有争论的观点则不予论述；三是实践，遴选的编著者应对该课程有丰富的教学实践经验，并在教材中尽可能地收录反映企业解决工业工程问题的实际案例。经过认真研究，我们确定了下列选题：工业工程——原理、方法与应用，生产计划与控制，物流工程与管理，现代制造企业管理信息系统，以上为第一批；人因工程，质量管理，决策支持系统，复杂系统解析，工程管理的模糊分析，制造系统建模与仿真，以上为第二批；工程经济学，工作研究，项目管理，工业工程计算方法(暂定名)，以上为第三批。

参加这套系列教材编写的是上面提到的这几所大学的老师们，他们都是相应课程的任课教师。他们根据自己教学过程中反复修改过的讲稿，又参考了国内外的相关文献，在较短的时间内完成了教材的编写。他们精选教材内容，配以实例讲解，使学生易于掌握；同时，他们也力图将最近几年工业工程的最新研究成果做简要的介绍，以使学生接触本专业的前沿。但是，由于编写时间比较仓促，编写者们的经验又各不相同，本系列教材的质量和水平一定是参差不齐的，也一定会存在一些缺点，希望能得到读者的批评和指正。

在工业工程系列教材出版之际，我们深感欣慰，并对辛勤工作的老师们表示感谢。祝愿工业工程学科在教育界、工程界同仁的关怀下茁壮成长。

工业工程系列教材编委会主任

中 国 工 程 院 院 士

前　言

“专业外语”历来是专业和外语的交汇课程，学员通过专业外语的学习，既可以对所学专业的专业知识温故而知新，又可将基础外语向前拓展一步，真正将学校所学外语延续到今后的日常工作，因此，“专业外语”为学员提供了一个终生受益的工具，也为他们今后走向国际铺垫了良好的基础。

本书基于上述目的，十分注重选材内容和编写格式，内容从大量北美、英国近些年来较为权威和读者数量大的书籍和杂志中精选而来，以确保专业内容权威、新颖和英语文法、习语的正宗规范。本书选材内容广泛，覆盖了工业工程所涉及的主要领域，如工业工程、系统工程、生产过程设计、生产设施定位布局、物流工程与管理、信息管理系统、人因工程、质量管理、项目管理、财务管理、人力资源管理、计算机应用等。文章选材尽量贴近工业工程专业的核心和主干内容，所选每篇文章都注意到内容的基础性和新颖性，力图将该专业基础性的词汇尽可能多地吸纳进来。学员学习后，既可掌握本专业的基础知识和新动向，又能奠定好阅读本专业外文文献的功底。为便于学员自学阅读，对每篇文章都给出了中文译文，以供参考。

本书由同济大学经济与管理学院白庆华教授主编，同济大学机械学院郑永前副教授担任副主编。其中：白庆华教授编写了第 1、2、15 章，负责全书的安排和总汇；徐克林教授编写了第 6、7 章；郑永前副教授编写了第 3、5、14 章，校对了第 9 章；陆瑶讲师编写了第 10、12 章；陆瑶讲师、杨宏波博士生共同编写了第 13 章、杨宏波博士生校对了第 14、15、16 章；同济大学研究生杨云飞、申剑、邓崧、李先锋进行了前期校对，研究生杨宏波、李亚丹、李洪宇、邬李波参加了后期校对工作。上海理工大学老师也参加了编写：许晓兵副教授编写了第 4 章，孙军华、张昕瑞老师编写了第 7 章，刘宇熹老师编写了第 8 章。西南师范大学数学与财经学院徐克勇副教授编写了第 11、16 章。

在本书出版之际，还应衷心感谢上海汽车工业教育基金会和上海交通大学出

版社的大力支持，特别感谢责任编辑陈岳老师为本书的定稿和出版做了大量的工作。

由于编者水平有限，书中存在的错误和欠妥之处，恳请读者批评指正。

编者

2009年2月于同济园

目　录

第 1 章　工业工程的概念及其发展史

1 Definition of & Introduction to Industrial Engineering

1.1 Definition of Industrial Engineering

The following formal definition of industrial engineering (IE) has been adopted by the IIE:

Industrial Engineering is concerned with the design, improvement, and installation of integrated systems of people, materials, information, equipment, and energy. It draws upon specialized knowledge and skill in the mathematics, physical, and social sciences together with the principles and methods of engineering analysis and design to specify, predict, and evaluate the results to be obtained from such systems.

As used in this context, the term industrial is intended to be interpreted in the most general way. Although the term industrial is often associated with manufacturing organizations, here it is intended to apply to any organization. The basic principles of industrial engineering are being applied widely in agriculture, hospitals, banks, government organizations, and so forth.

Read the definition again. Think about any large factory that you have seen in which thousands of workers, hundreds of machines, a large variety of materials, and millions of dollars must be combined in the most productive, cost-effective manner. Think about a large city that also requires thousands of workers, hundreds of vehicles and other machinery, materials, and millions of dollars in order to deliver services required by the public. Imagine how much more effectively the city could be run if the principles of industrial engineering were applied.

The current definition of industrial engineering needs little or no modification to be a suitable definition for "industrial and systems engineering" in which the overall system design is emphasized.

1.2 Introduction to Industrial Engineering

Industrial engineering is about choices. Other engineering disciplines apply skills to very specific areas. IE gives you the opportunity to work in a variety of businesses. The most distinctive aspect of industrial engineering is the flexibility that it offers. Whether it's shortening a roller coaster line, streamlining an operating room, distributing products worldwide, or manufacturing superior automobiles, all share the common goal of saving companies money and increasing efficiencies.

As companies adopt management philosophies of continuous productivity and quality improvement to survive in the increasingly competitive world market, the need for industrial engineers is growing. Why? Industrial engineers are the only engineering professionals trained as productivity and quality improvement specialists.

Industrial engineers figure out how to do things better. They engineer processes and systems that improve quality and productivity. They work to eliminate waste of time, money, materials, energy, and other commodities. Most important of all, IEs save companies money. This is why more and more companies are hiring industrial engineers and then promoting them into management positions.

Industrial engineer is synonymous with systems integrator—a big-picture thinker, in other words. It's an employee who takes what exists today and conceptualizes what should exist in the future. A lot of engineers become disillusioned with the engineering profession because they get involved in minutiae or they end up on a CAD machine all the time, and they never get out in the factory environment or the operating environment. That's not what happens to an industrial engineer. IEs spend most of their time out in the real operating environment, coming up with scientific approaches to problems rather than seat-of-the-pants, temporary solutions.

Many people are misled by the term "industrial engineer". The "industrial" does not mean just manufacturing. It encompasses service industries as well. It has long been known that industrial engineers have the technical training to make improvements in a manufacturing setting.

Now it is becoming increasingly recognized that these same techniques can be

used to evaluate and improve productivity and quality in service industries.

Here are a few examples of what an IE might do:

- Develop and implement a computer-based information system
- Develop a bar-code tracking system
- Develop an optimal production schedule for a manufacturing facility
- Decide on the best way to manage the distribution of a company's products
- Streamline a hospital's emergency room
- Improve quality and efficiency in an automobile production line
- Develop an optimal plan for refining crude oil into various petroleum products.
- Find the best way to lay out machines and equipment on a shop floor
- Schedule flights and crews for an airliner

【Vocabulary】

be disillusioned with	*vt.*	对……大失所望
by the seat of one's pants		[俚]凭直觉;凭本能
bar-code	*n.*	条形码
decide on	*vt.*	对……作出决定
service industries	*n.*	服务业

【参考译文】

1　工业工程定义和简介

1.1　工业工程定义

国际工业工程联合会(IIE)对工业工程(IE)采用如下正式定义：

工业工程指对人、原料、信息、设备和能源等组成的集成系统进行设计、改进和安装。它利用数学、物理和社会科学中的专业知识和技能，与工程分析和设计的原理和方法相结合，以确定、预测和评估来自系统的结果。

如本文所述，“工业”一词涵盖广泛。虽然“工业”一词常常让人联想起制造业组织，但这里适用任何组织机构。工业工程的基本原理正被广泛应用于农业、医院、银行、政府组织等。

重温定义，想想一个大型工厂，里面有成千上万名工人，成百上千台机器，无数

种原材料和数以百万计美元的投入，这些资源结合在一起并以最有效的、最低成本的方式运作。想想一座大城市，那里同样需要成千上万名工人，成百上千的交通工具和其他机械、原料和数百万美元的投入，来为公众服务。可以想象，如果广泛应用工业工程的原理和方法，城市管理效率将会得到多大的提高。

现在对工业工程的定义只需稍微变动或者不需要调整就可以成为“工业与系统工程”的贴切定义，“工业与系统工程”强调系统整体设计。

1.2 工业工程简介

工业工程是一门有关选择的学科。其他的工程学科是将专业技能用于各种特定领域。工业工程使你可以有机会在不同的行业工作。工业工程最与众不同的特点就是它所呈现的可变通性。无论是缩短过山车的线路，使手术室简化并更有效率，在全世界推销产品，还是生产制造更高级的汽车，工业工程的目标都是为了替公司节约开支和提高效率。

由于公司为了能够在竞争日益激烈的国际市场上生存，采用了持续的生产力和品质改进的管理原理，它们对工业工程师的需求随之增加，原因在于工业工程师是唯一作为生产率和质量提高方面的专家而培养的工程专业人员。

工业工程师考虑如何把事情做得更好，工业工程师设计程序和系统来提高质量和生产率。他们的工作可以消除时间、金钱、材料、能源以及其他物品的浪费。最为重要的是工业工程师可以为公司节省资金。这就是为什么越来越多的公司雇用工业工程师，然后提拔他们进入管理层。

工业工程师就是系统集成的同义词，换言之，是大格局的构想者。他们是根据现存的情况来构思今后应该出现什么局面的公司职员。因为许多工程师陷于细枝末节或者花费所有的时间在计算机辅助设计上，他们从不会离开岗位而到实际的制造环境或操作环境中，所以他们对工程师职业大失所望。这种事情不会发生在工业工程师的身上。工业工程师会到实际的操作环境中，花大部分时间去研究现实情况，提出科学的解决问题的方法，而不是凭经验或直觉提出临时的解决方法。

许多人被“工业工程师”这一术语所误导。“工业的”不仅仅指制造业，同样也包含服务业。长久以来人们认为工业工程师是经过专门技术培训来改进制造装配的，现在人们愈加认识到这些相同的技术能够用于评价和提高服务业的生产率和质量。

以下是关于工业工程师可能从事的工作的几个例子：

- 开发并实施基于计算机的信息系统
- 开发条形码跟踪系统

- 为制造设备制定最佳的生产计划
- 选择最佳的方法来管理公司产品的配送
- 设计流水化作业以改善医院急救室的效率
- 提高汽车生产中的质量和效率
- 制定将原油精炼成各种石油产品的最优方案
- 找到在车间布置机器、设备的最佳方法
- 为大型客机制定航班表和机组人员工作日程

2 Impact of Related Developments

The evolution of the industrial and systems engineering profession has been affected significantly by a number of related developments. We discuss several of these in this section.

2.1 Impact of Operations Research

The development of industrial engineering has been greatly influenced by the impact of an analysis approach called operations research. This approach originated in England and the United States during World War II and was aimed at solving difficult war-related problems through the use of science, mathematics, behavioral science, probability theory, and statistics. The approach enjoyed rather good success.

Following World War II the concepts of operations research were extended to problems in industry and commerce. A large number of mathematicians and scientists began devoting attention to a wide variety of operational problems. This resulted in considerable interaction between industrial engineers and members of other scientific disciplines. The infusion of new ideas and new approaches to problem solving had a dramatic impact on industrial engineering education and practice.

Industrial engineering departments at many universities began offering course work and complete options (usually at the graduate level) in operations research. In fact, some academic IE departments have changed their names to Industrial Engineering and Operations Research.

As it was originally conceived, the operations research approach was as follows: A specific problem was identified; specialists from appropriate fields

were formed into an interdisciplinary task force to develop a solution; appropriate scientific methods and principles (usually involving mathematical models) were brought to bear on the problem; consideration was given to the interaction of the various components in the system being studied; the "best" solution was decided upon and presented to management. Once the work of the task force was completed, the task force was disbanded.

An approach such as this essentially precludes the establishment of operations research as a separate discipline. One person simply cannot have expertise in all the scientific areas that might be needed for problem solving.

As currently used, the term operations research connotes a set of quantitative methods that are applicable to a wide range of managerial and operational problems. Consequently, very few people consider themselves as operations researchers. Many industrial engineers do consider operations research as being their primary interest.

2.2 Impact of Digital Computers

Another development that has had a significant impact on the IE profession is the digital computer. Digital computers permit the rapid and accurate handling of vast quantities of data, thereby permitting industrial engineers to design systems for effectively managing and controlling large, complex operations.

Many of the methods of operations research, discussed in the preceding section, require extensive calculations. The digital computer permits industrial engineers to exercise a wide variety of optimization techniques to assist decision makers to better allocate scarce resources.

The digital computer also permits industrial engineers to construct computer simulation models of manufacturing facilities and the like in order to evaluate the effectiveness of alternative facility configurations, different management policies, and other management consideration. Computer simulation is emerging as the most widely used IE technique.

A recent development that is having a profound (although still uncertain) impact on industrial engineering is computer-aided design (CAD) and computer-aided manufacturing (CAM). Industrial engineers are now designing facilities and work spaces directly on a computer workstation. The computer is also being used to automatically generate process plans, bills of material, tool release orders,

work schedules, operator instructions, and so on. During production, computers are used to control the cutting path of machine tools, send instructions to robots and other devices, record production progress, dynamically reschedule work centers, and automatically generate reports to all levels of management.

The development and widespread utilization of personal computers is having a dramatic impact on the practice of industrial engineering. industrial engineers use PCs extensively to perform various analyses, to execute mathematical models, to plan and manage complex projects, to create databases, and to implement a wide range of decision support tools.

Computer networks are being developed for companies that will permit all computers (even those made by different companies) to "talk to each other". In this mode, managers, supervisors, and machine operators may gain access to vast amounts of information that is stored in different computer systems, but accessible through the network.

The industrial engineer's role in the computer environment described above is to perform the overall system design, which effectively links together the various components of the system. Essentially every IE tool and technique will be affected by developments in computers and communications.

2.3 Emergence of Service Industries

In the early days of the industrial engineering profession, IE practice was applied almost exclusively in manufacturing organizations. After World War II there was a growing awareness that the principles and techniques of IE were also applicable in non-manufacturing environments.

One of the first service industries to utilize industrial engineering on a broad scale was the health-care industry. Many hospitals and clinics employ industrial engineers to improve their operations, eliminate waste, control inventories, schedule activities, and for a wide variety of other functions.

A more recent area to utilize industrial engineers is that of government agencies. This is now occurring at the national, state, and local levels. Thousands of industrial engineers are employed by government organizations to increase efficiency, reduce paperwork, design computerized management control systems, implement project management techniques, monitor the quality and reliability of vendor-supplied purchases, and for many other functions.